Magnetic Shape Memory Alloy Actuator for Instrument Applications

Completed Technology Project (2014 - 2015)

Project Introduction

This project will develop a simple actuator based on magnetic shape memory alloy (MSMA), a novel new family of crystalline materials which exhibit strain deformation >10% when subjected to a magnetic field. These materials have the unique property of retaining their strained state when the driving field is removed, making them unique in the world of shape memory materials, and desirable as an actuator material as they will maintain position when powered off. MSMA can potentially replace current shape memory alloys in many spaceflight instrument applications, as well as enable new precision mechanism types.

The objective of this project is to develop a simple, small linear actuator system using magnetic shape memory allow capable of self-position sensing and power-off position maintenance. The actuator system will consist of a laboratory bench-top linear actuator, breadboard-level control electronics, and a computer command interface. The effort is a technology maturation of MSMA mechanisms, which are currently at TRL 2/3, and we intend to bring them to TRL 4. Boise State University (BSU) is a research partner and will provide MSMA crystals and contribute design consultation.

The innovative elements of this technology lie in the use of MSMA, which combine many very desirable properties lacking in other shape memory alloy materials. Similar to conventional SMAs, MSMA exhibit a large, reversible shape change related to a crystal structural transformation. Unlike conventional SMAs, which utilize temperature or voltage as the control parameter, MSMAs are driven by a magnetic field. Fields can be applied with very short response times making MSMA-based actuators kHz capable. Furthermore, the magnetic-field-induced deformation is permanent, and reversible. Holding a constant position does not require power. Also, positioning is highly precise with accuracy in the nanometer range. These properties of MSMA-based actuators will increase the accuracy of earth and space science instruments and reduce operational power consumption.

Anticipated Benefits

The application of MSMA actuators can be applied to earth science, space science, heliophysics, CubeSat and other SmallSat-class instruments.

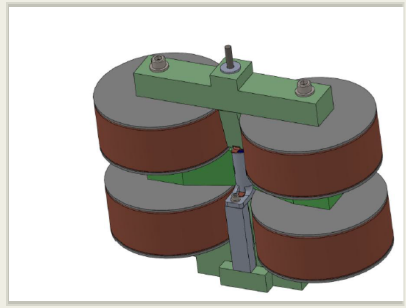

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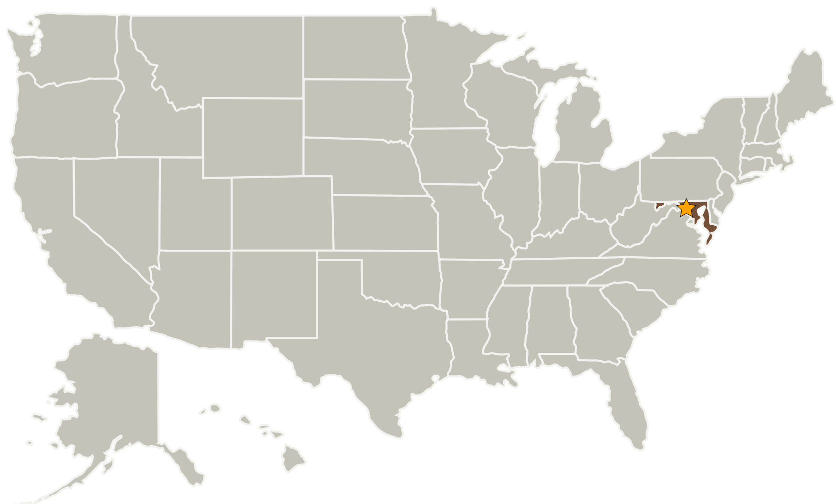
Table of Contents

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Co-Funding Partners	Type	Location
Boise State University	Academia	Boise, Idaho

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

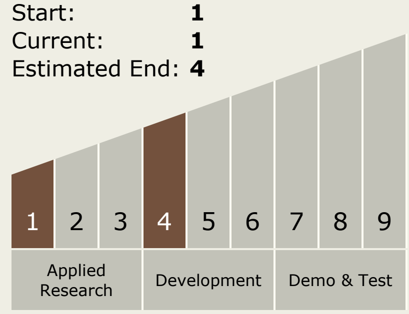
Michael J Viens

Principal Investigator:

Umeshkumar D Patel

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **4**



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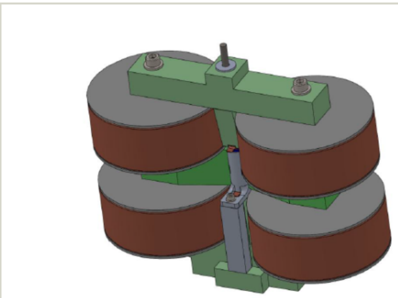
Images



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Magnetic Shape Memory Alloy Actuator for Instrument Applications
(https://techport.nasa.gov/image/16657)

Project Website:

http://aetd.gsfc.nasa.gov

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  └ TX12.1 Materials
    └ TX12.1.8 Smart Materials